Graph Analytics using Partition-centric Processing

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Introduction and Background

Graph analytics is widely used for various application domains

| Social network | Internet | Road Network |

Challenges

- Communication: volume, irregularity
- Synchronization: atomics, locks

SHARP$^1$ Toolkit for DARPA HIVE

- Novel parallel programming models
- Efficient memory data layouts

Partition-centric Processing

NOVEL GRAPH ABSTRACTION

- Center of computation → vertex, edge, partition (cacheable set of vertices)
- Graph is viewed as a set of links between vertices and partitions

COMPUTATION MODEL

- Gather-Apply-Scatter (GAS) programming model
  - Scatter vertex values as updates
  - Gather incoming updates to compute new vertex values
- Statically allocate bins for updates
  - Process multiple partitions in parallel
  - Asynchronous within each phase → no locks/atomics
- Vertex data of partition cached → low latency random accesses

COMMUNICATION MODEL

- Volume Reduction → send updates to nodes partitions
  - Node labeling optimization
- Irregularity → only 1 bin is written by a thread at a time. Random DRAM accesses avoided.

Results on PageRank

Platform: Intel Xeon E5-2650 v2 Ivy-bridge, 16-cores

Baselines: Pull direction PageRank (PDPR), state-of-the-art Vertex-centric GAS (BVGAS)

Datasets: upto 100 M vertices & 1.95 B edges

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TABLE: DRAM communication (in GB) per iteration with original and optimized node labeling

Summary of Comparison with state-of-the-art (IPDPS’17 best paper)

- 2.7 × average speedup
- 1.7 × average reduction in communication volume
- 1.6 × higher sustained memory bandwidth
- Performance improves further with graph locality

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1. projectsharp.usc.edu